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ABSTRACT

This document reviews a computer management system which uses as its substructure an outcome-based approach to curriculum development. It details the philosophical and pedagogical bases for the adoption of such a computer-managed instruction system and offers a wide range of practical suggestions for computer uses in education. The philosophical constructs underlining the goals of this program are consistent with the concepts of Outcome Based Education instructional delivery systems, which define curriculum development by instructional objectives and which dictate that the system be student centered, simple but powerful, decentralized, and accessible. This computer-managed instruction system provides for diagnosis and summative post-testing through application of an item bank, fashioned in linear vertical sequence through Rasch item response scaling and coded by format and complexity. In this way, the systems are used to evaluate student progress and instructional programs and provide indicators for student grouping and placement. The system also has the capability to prescribe an appropriate correction for students by incorporating a resource file coded to higher order thinking skills, learning styles, and instructional pedagogy as defined by Madeline Hunter. Recordkeeping is an important function of the system, as is the parent/school partnership program. IBM PCXT computers have been placed in each school site; they present many advantages to users. Detailed lists of systems operations, including diagnosis, prescription, reporting, and record keeping functions, conclude the document. (IW)

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Planning and Using a Computerized Instructional Management System

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COMPUTER MANAGED INSTRUCTION

The objective of this presentation is to review a computer management system which uses as its substructure an outcome based approach to curriculum development as defined by instructional objectives. It provides for diagnosis through application of an item bank fashioned in linear vertical sequence through Rasch item response scaling and coded by format and complexity. It also has the capability to make prescriptions by incorporating a resource file coded to learning styles, higher order thinking skills, and instructional pedagogy as defined by Madeline Hunter.

Philosophy

1. Student Centered
2. Outcome Based
3. Simple/Powerful
4. Immediate Access
5. Decentralized
6. Learning History

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PHILOSOPHICAL PERSPECTIVE

Any system of instruction is ultimately driven by the fundamental belief in the nature and purpose of the system. The philosophical constructs which underline the operation of this system are as follows:

1. The system must reflect actual practice in the classroom. Some researchers call this curriculum matching. This is the key to the success of the system. The system must conform to the teacher rather than the teacher conforming to the system or book thereby being limited by the content of the book. The system must match the real curriculum. There is an adage that once the curriculum guide is produced, teachers go into the classroom, close the door and begin teaching what they feel or what their belief system dictates as crucial. The attempt is to function from one system. Textbooks and other materials should conform to teacher defined goals. District objectives and guides should emanate from validated successful practice as defined by the implementation system.

2. The system must yield more information than is currently accessible to the teacher. The information must be in a format that is simple to interpret. The system must be able to summarize all currently available data on student growth and learning history into class profiles which formatively assist the teacher in sound decision making.

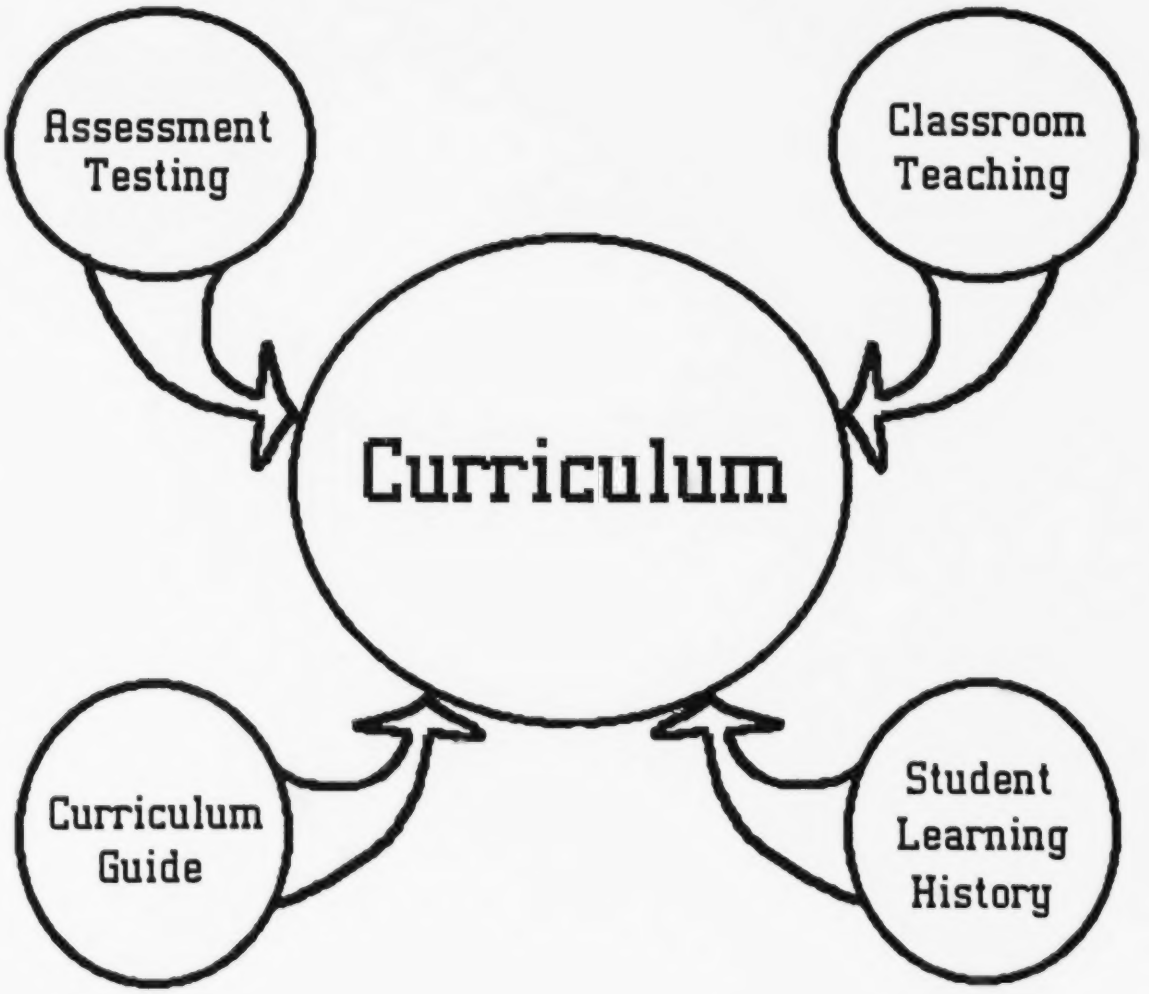
3. The system must be immediately accessible to teachers. Teachers are extremely busy and do not have the time to wait long periods of time for a computer system to generate a report. The speed of the system must always be a consideration. If the teacher can generate the information faster than the computer, the computer is impeding decision making rather than facilitating it. The system must be operable "where the rubber meets the road." It must be decentralized to the degree that it provides direct support for those individuals needing the information. Test generation, scoring and reporting must occur at speeds that ensure the system is waiting for the user and not the user waiting for the system.

4. The goals of this program are consistent with the concepts of Outcome Based Education instructional delivery systems. Allen Cohen has described the Outcome Based Education philosophy with the acronym DAPVAR, which means; (1) Precise definition of the instructional outcomes, (2) Alignment of instructional goals to test what we teach and teach what we test, (3) Program design in short modules of learner activities, (4) Varying the rate of progress - not all students

progress at the same rate, (5) Assessing the behavior in relation to the intended instructional outcome, and (6) Recycle by trying a new set of materials or strategies with the student who does not master the instructional outcomes.

5. The system must be designed to take children from where they are as far as they can go. To be fully functional it must first give empirical and objective evidence about student ability and skill. Research has clearly substantiated that the most effective instruction takes into consideration the prerequisite skills of a student and makes accommodations for students lacking these skills.

Curriculum



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INSTRUCTIONAL OBJECTIVES

The traditional form of curriculum definition has been by means of a textbook selection review committee which examines available texts and makes a recommendation to the Board. This process focuses on a different area each year and at the end of five years the cycle repeats itself. Available funds for a textbook adoption are expended for one resource which becomes the source of instruction. The objective in this model is to move through the book by covering so many pages in a given amount of time.

Our model, although it seems like a simple philosophical difference, in actuality is a major departure from tradition. The source of instruction in our model is the teacher. All objectives flow from the expertise and professional background of a synergistically focused teaching staff. Instead of one textbook becoming the source of instruction, we require by policy, that objectives will be taught from a variety of materials incorporating different model presentations, learning style correlates, and higher order thinking constructs as defined by Bloom.

Developing appropriate instructional objectives is the initial task in this model. It is the most critical element because it establishes all other systems both in the definition of outcomes and the diagnosis and prescription functions of the computer system.

Development of instructional objectives has been defined as a strategy consisting of deciding in advance what the final product or outcome ought to look like and then using this picture as a guide to suggest methods for developing and measuring it.

This curriculum is stated in terms of terminal objectives. Terminal objectives are those objectives which students are expected to perform upon completion of each grade level. The instructional objectives emphasize what is "learned" and allows a teacher, student, or parent to see exactly what skills a student has mastered.

The objectives contained in our curriculum guide define approximately 60% of the formal curriculum and represent the highest priority or essential learnings for each subject. Forty percent of the curriculum is left to teacher discretion. The rationale being that each teacher will emphasize different enrichment areas which is a positive influence on the curriculum derived from their unique backgrounds and interests. By defining the core of the curriculum, but allowing uniqueness, we accommodate both consistency and individuality.

The Instructional Objectives represent the course of study for each subject prescribed by the Board. The instructional objectives are used as the educational criteria for selection of textbooks, materials, activities, computer programs, and all other modes of instruction. These objectives accommodate a variety of learning and teaching styles. They allow flexibility of method and materials without disorganization of content.

Performance objectives do not dictate learning style nor teaching style. Professional expertise and professional judgment on the part of the teacher are essential in the choice of methods, techniques, materials, and environment suitable to the educational needs and learning style of each individual student. The use of a uniform series of performance objectives is intended to make sure that all students learn the essential skills to the greatest extent that their individual potential allows.

Because the system is continuous and uniform from grades K-12 within our school district, it serves as the long sought after vehicle for assessment for individual student skills as the student progresses from year to year and ultimately to graduation.

Systematic Program Evaluation

Component 1

Instructional Objectives

1. Outcomes
2. 20-25 per subject/grade

Component 2

Item Bank

1. Rasch
2. Blooms
3. Types
   multiple choice
   teacher observable
   matrix

Component 3

Resource File

1. Blooms
2. Learning Style
3. Modality
4. Pedagogy
5. Type

Component 4

Student Profile

1. Demographic
2. Learning Style
3. Modality
4. Learning History

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INSTRUCTIONAL DEVELOPMENT CYCLE

Instruction is defined in two stages. Stage one is the definition of expected terminal student outcomes at the conclusion of each grade level. This provides two pieces of information. First it describes the capabilities of students in each subject at each grade level, and second it forms the basis for summative evaluation. As pre and post criterion referenced tests are given each year we can document student gain as well as define the scope of the curriculum.

Step 1. Conduct in-service workshops to acquaint staff with the concept and process of developing instructional objectives.

Step 2. Establish district goals in all areas. The first step in our process was to call a meeting of all teachers for a given subject at a given grade level. The teachers then participated in a Q-sort activity. Each was requested to write the highest priority teacher expectations for students leaving their classroom at the conclusion of the school year. These were then sorted into piles of equivalent statements. The compilation of these statements were then prioritized and reduced to a maximum of 25 instructional objectives for a given subject at a given grade level.

Input from all teachers is essential. If a small group does the actual writing, all teachers are kept informed of progress and are encouraged to ask questions and suggest revisions. Parent and student input should be considered where appropriate. The scope and sequence should be based on the needs of the local school district.

Step 3. Articulation of curriculum by tracing vertical content strands in both task and path analysis from grade to grade. This aligns our curriculum in sequence and provides the basis for a student learning history profile which follows them through the course of instruction.

Step 4. Teachers in each of the instructional areas coordinate the selection and/or development of appropriate test items, evaluation instruments, and evaluation strategies derived from the performance objectives.

Step 5. Have teachers develop and organize appropriate learning experiences derived from the performance objectives, including methods, materials and classroom management.

Step 6. Develop an alternative learning plan for the district. This is accomplished by having each of the teachers code and share material

they have found to be successful in teaching a particular objective. These items are then coded by learning style, modality, Blooms taxonomy and type of activity.

Step 7. Develop a recordkeeping system that assures an accurate record of student achievement of objectives.

Step 8. Develop a parent reporting system that will help parents to assist in the education of their child.

Step 9. Evaluate the system and revise, as necessary, based on compiled lists of problems and suggested solutions.

Diagnosis

1. Continuous Formative
2. Multiple Methods
3. Prerequisite Skills
4. Computer Adaptive

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DIAGNOSTIC FUNCTION

The summative testing function of the system is accomplished through pre and post tests which are used to:

1. Evaluate student progress
2. Provide diagnostic information for instructional purposes
3. Provide an indicator for student grouping and placement
4. Identify goals for emphasis
5. Evaluate instructional programs
6. Provide information for planning
7. Provide accountability to the school board and community

For each of the objectives defined in the instructional program there are four items used in a summative post test which yield the information cited above.
Items are classified by:

1. Type (multiple choice, teacher observable, analytical grid essay)
2. Difficulty (Rasch Calibration - item response theory)
3. Blooms Taxonomy

These items are coded into the computer so that as reports are generated by the computer it can summarize the data across any of the variables contained in the student learning history file.

Formative criterion-referenced evaluation is used on a continuous basis. When the teacher and the student have determined subjectively that the student has learned a particular skill or group of skills, they use a formative test to find out whether or not a student has achieved the objective or group of objectives. If the student passes the test at the previously agreed upon level, then the student progresses to the next objective or group of objectives. If the formative test shows that the student has not achieved the objective, then the teacher uses an alternative learning procedure to further assist the student achieve the objective.

Although the focus of this approach to instruction is on learning rather than on teaching, it requires the highest degree of skill, professional knowledge, and flexibility on the part of the teacher.

It is not necessary to evaluate student progress daily, or to test one learner at a time. One day of the week can be set aside to test each student on the appropriate objectives. Usually, this does not require

a different test for each individual, as many are working on the same objectives at the same time. Another possible alternative is to assign tests for certain objectives to each day of the week so that students can choose their test days according to the skills they feel ready to demonstrate. There are many testing arrangements possible with criterion-referenced evaluation and such decisions are left to the professional judgment of the teacher, with appropriate support from the administration.

Summative criterion referenced tests are given on a district basis. Results of the district CRT's and the SRA are used for decision making and for reporting student progress to patrons of the district.

On a formative basis an item bank is employed which can generate a test over a wide range of objectives with flexibility in the format, difficulty, length of the test, number of items, etc. These results of evaluation are used to help the teacher prescribe further instruction for the student. A student's record of accomplishments follows him/her from one grade level to the next. Ideally, this progress report also follows the student in transferring from one school to another within the system. The student profile has the capability to aggregate any of the variables in the analysis of the testing function.

Prescription

1. Resource File
2. Multi-method
3. Multi-media
4. Modalities
5. Learning Styles
6. Blooms Taxonomy

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PRESCRIPTIVE FUNCTION

An alternative learning plan is a different method or the use of different materials more appropriate to the needs of a particular student.

Alternative learning plans are an essential part of any education system that recognizes that each individual learns in a different way. Alternative learning plans are appropriate for different types of students and would be used to help answer the following questions:

1. What happens if the student cannot demonstrate accomplishments of the objective after receiving the prescribed instruction?

2. What happens if the student has achieved all objectives for the proper grade level and three or four grade levels beyond that?

3. What happens if a particular student is having great difficulty, generally, in performing in the classroom?

These situations require an alternative plan. The teacher may have an alternative plan. The teacher may have a personal collection of time-tested methods and/or materials, or the school or school district may provide a bank of suggested methods and materials coded to each performance objective on the continuum. If the teacher has used all available means of working with the student, then the teacher turns to the alternative learning procedures available at the school level, such as the instructional center or special resource program, or requests an administrative decision from the principal. The interaction of the diagnostic function of the system and the alternative learning plan provides a dynamic basis for prescribing an appropriate correction for students.

Recordkeeping

1. Longitudinal
2. Learning History
3. Flexible
4. Automatic Profiles

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RECORDKEEPING SYSTEM

A computerized instructional management system includes a record keeping system that provides:

1. an accurate record of a student's achievement of objectives.

2. maintenance and updating of the record for as long as the student is in the system.

3. availability of the record from previous years to the student's present teacher.

4. transference of the record when the student enrolls in a different school within the system.

5. automatic generation of class profiles as they register for the subsequent year.

In addition to this it is necessary for the teacher to know, on an ongoing basis, which objectives the student has achieved. The individual student record itself provides a computer data base of information relating to the learning history of each child in the system.

Partnership Program

1. Parent/School
2. Remediation Systems
3. Alternative Activities
4. Take Home Computer
5. Laser Disk Systems
6. Home Education Programs

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PARTNERSHIP PROGRAM

The parent reporting system informs parents about their children's progress in school. The system may consist of a written report, a series of conferences, or any other means of communication that meets the needs of parents to be informed about what their children are learning in school. The use of performance objectives makes it possible to report to the parent exactly what the student has learned.

An orientation session held by principals for parents at the beginning of the school year is helpful in acquainting parents with the reporting system and in explaining any technical language contained in the progress report. Additional information may be included: e.g., an indication of which skills the student is currently working on in addition to those already mastered, recommendations and commendations, teacher comments, parent comments, and student comments.

The most effective parent reporting system is one that has been developed in response to input from teachers and parents as to the method, frequency, purpose, format, and content that would be most meaningful to them, and one which encourages parents to assist in the formal education of their children.

Computer Operation

1. Diagnosis
2. Prescription
3. Reporting
4. Record keeping

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SYSTEM OPERATION

We have placed IBM PCXT computers which are attached to NCS 3000 Scanners in each of our school sites. These can work as independent work stations or they can communicate via emulation into the main computer of the school district. When a teacher wishes to administer a test over a given number of objectives s/he can access the item bank through the computer in the media center or work room and either select from the items available for the particular objectives or have the computer randomly generate the items. Teachers can specify a particular level of Blooms or a particular level of difficulty. They can also instruct the computer to randomly select a varied number of items across all levels of Blooms and within a range of difficulties. The summary data from this type of analysis will give teachers empirical support for assessing student abilities as well as develop profile assessment of an entire class. They can determine at which level of Blooms the majority of the class is functioning and they can also identify students who are functioning considerably above or below the rest of the class.

The computer assists teachers in the instructional process by analyzing the data in light of the student learning history, prerequisite skills, and other variables in the student profile. It aggregates this data at the class level. Students begin courses or units of study, and, after completion of assignments, are tested over any combination of objectives with multiple formats if desired. If test results meet certain criteria, the student is said to have reached mastery.

The coding of instructional objectives in the computer can be set in any or all of the following modes:

* linear; there are no optional sequences for the student to follow.

* a tree; curriculum units are ordered and linked to create an interconnected hierarchy leading to a final objective. Units at the lower levels of the "tree" may serve as prerequisites for several future units.

* a menu; the total course is divided into units which can be taken in any order.

* a block; the curriculum is divided into major topics, each

containing a number of units. The student is free to work on units in any order until block or topic is completed.

* a strand; there are various linear arrangements where the curriculum is divided into major areas. The student may work on a unit from one or more strands concurrently.

* a spiral; contains review units after a number of units to create a "spiral" curriculum.

The system:

* backs up student data automatically.

* contains security arrangements which deny access to stored data to unauthorized personnel.

* requires each user to have a unique sign-on password to allow inspection and editing of materials, tests, and records.

* allows the system data to be edited.

* allows the system data to be compressed.

* allows the system data to be sorted.

* contains publisher's predetermined objectives.

* permits the addition of locally developed objectives, tests, materials and prescriptions.

* manages all instructional areas.

* Instructional data processing is done interactively during the school instruction hours.

* Data can be entered through the keyboard or scanners.

The system provides the option to:

* use skills and objectives in the sequence in which they occur in the system.

* rearrange the sequence in which skills and objectives occur in the system.

* delete skills or objectives in the system and input the district's skills or objectives.

* override or waive an objective based on teacher decision.

* Objectives or skills which are observable but are not tested on paper, may be certified as mastered by the teacher.

DIAGNOSIS. The computer can construct, preslug, and analyze tests for diagnostic and assessment purposes.

The system generates:

* pre-tests and post-tests keyed to objectives, sequences, or clusters.

* tests presented via a computer terminal.

* assessment instruments that are machine-scored.

* observation techniques that can be scored via an analytical matrix.

* multiple versions of each test through the use of an item bank, for each unit of study or objective.

* randomly selected items from item bank and prints a test after the user designates the topic area objectives and number of items needed.

* test items classified by item difficulty in a linear vertical sequence (Rasch item response scaling).

* test items classified by behavioral level (application of Blooms taxonomy).

* alternate formats, with questions arranged according to their type, machine-scored (multiple choice) and teacher-scored (essay).

* criterion referenced tests.

* standardized diagnostic tests.

* entry level (placement) testing prior to the course of study.

* tests that cover multiple topics or objectives, with the user determining how many items to be used for each sub-topic.

* practice tests, tailored to the student's prior test performance, are available to students on request (these can be machine generated and scored but not applied to the profile).

* suggestions for non-written assessments of objectives.

* a test item matrix report offering an item by item analysis.

* The system contains an objectives bank, which allows the indexing of test items that relate to the objectives in the construction of tests.

* The system supplies "scoring guides" to assist in interpreting results.

* Hand-scored items, when part of a larger assessment, are scored and recorded with machine-scored items.

* Teachers are involved in creating evaluation instruments.

* The user may choose to look at all test items for a topic and select specific items to be used for the test.

* The system provides master test booklets for all objectives that the user reproduces as needed.

* Test items are stored in an item bank by; characteristic keywords, contents, related objectives, level of difficulty, Blooms, and format.

* The system can provide feedback in one or more of the following forms:

    * indication of correctness/incorrectness of an answer.

    * messages indicating what is wrong with a given response.

    * analysis of a class or building by use of analytic distractors.

    * indication of mastery/non-mastery of objectives.

PRESCRIPTION FUNCTION Based on academic history, ability, learning style, and other student information, the computer should provide the user with prescriptions concerning the selection of materials, and assignments of courses needed for the completion of objectives. The system's curriculum objectives are keyed to tests with preset levels of mastery, generating a prescription based on a predetermined prescriptive formula.

The system:

* contains CAI material in a learning material bank, in which a student can be tested on the computer and branched to CAI.

* contains off-computer learning materials in a materials bank.

* provides printouts of instructional material, as determined by a prescription. (capability to incorporate worksheets and instructional text on the computer)

* contains a wide variety of instructional resources coded by modality and learning style, linked and indexed to objectives, in a learning resource bank.

* creates and maintains schedules for resources.

* offers a link of several subject matter areas to a common educational goal.

* allows the student freedom to pursue topics beyond the main course of study or to expand an area already mastered.

* generates a tentative instructional plan of objectives based on the student's prior performance and other variables.

* generates the predicted completion time for a learning activity.

* collects a variety of data for use in evaluating the instructional processes: study time, prescriptions, intervals between attempts, and number of attempts.

* forms, restructures, or eliminates instructional groups, based on the most recent student information.

The system:

* Teachers are involved in formulating the system's educational objectives.

* contains publisher's predetermined assignments.

* contains teacher-developed assignments.

* contains a "browsing" module permitting precise selection of those items used in instruction, printing only those items used in instruction, printing only those items a teachers chooses to use instead of all the material available to teach an objective.

* generates prescriptions containing a variety of materials: text books, tapes, films, models, computer software, etc.

* considers prior academic performance in making prescriptions.

* considers factors such as learning style, aptitude, student interest, and cognitive style in making prescriptions.

* generates a remedial prescription if, after instruction, a student has not mastered an objective.

* assigns a beginning prescription, with prescriptions of different techniques or procedures being held in reserve.

* generates a printed prescription informing the student of the assessment and what to do next.

* provides a "menu" of prescriptions for the objective and the teacher/student selects the one most appropriate for student.

* allows the teacher to make an alternate prescription.

* generates prescriptions that consider available instructional resources and the number of students assigned to certain materials.

* allows the teacher to choose the information necessary to make instructional decisions from the large amount of data found in the system.

* indicates the location of materials called for in prescriptions, e.g., media center.

REPORTING FUNCTION The computer generates lists and reports, contains student, teacher and curriculum information from a variety of organizational settings; individual, class, school and district. Reports on student performance and progress are available to students, parents, and teachers.

The system generates a report containing:

* student demographics

* objectives mastered by individual students.

* a cumulative performance record of each student over the course of his/her academic career.

* a frequency count of unsuccessful prescriptions.

* a graphic presentation (profile or graph) of student or class progress.

* class groupings and subgroupings based on needs.

* a flexible reporting of student progress, with frequency levels controlled by the teacher.

* the names of students who did not attain mastery on each objective.

* the percentage of students mastering each objective.

* resources available to a student for reteaching an unmastered objective or skill.

* the names of students presently working on a unit or objective.

* a list of all units presently being taught (electronic lesson plans).

* updated information on student progress (student or class profile) that is immediately available to the instructor and the administrator at the building site.

* reports to parents and students congratulating the student for skills mastered.

* materials or assignments to be done at home by the student demonstrating mastery and reinforcing the skills or enrichment/ extension activities.

* messages for students concerning social-personal or academic matters.

RECORD KEEPING FUNCTION The computer can maintain data about student progress and performance: information on learning styles, intellectual ability, age, and social economic factors.

The system:

* contains a students academic history file.

* contains a class roster file as well as a building file.

* stores data on all test results and subsequent prescription selections.

* maintains a record of assignments for future assessment of material effectiveness.

* stores individual test item responses for use in item analysis.

* allows adding or removing student names from specific educational programs.

* encompasses multiple cross-course records, i.e., a math prerequisite for a science unit.

* performs a statistical analysis of student performance data.